



OFF-SITE RADIATION FROM OPERATION OF
NEUTRINO AREA MUON LINE AT 225 GeV/c

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Operation of the Muon line in the Neutrino Area produces unplanned stray beams. These beams have previously been described at 150 and 275 GeV/c (TM-497 and TM-680). This memo describes the measurements and conclusion from operating the Muon line at 225 GeV/c and compares the beams to those predicted by the Monte Carlo program "HALO".

As before, the data were collected using a mobile environmental radiation lab (MERL). The MERL is equipped with two 8" x 8" scintillation counters with the associated fast electronics. The MERL is also equipped with a telemetry system which receives the N ϕ SEM so that the data can be normalized. The beam line was tuned to 225 GeV/c positive muons, with a μ/p ratio $\approx 10^{-7}$. In addition some data were taken with the $\mu/p \approx 0.7 \times 10^{-7}$ and 0.85×10^{-7} .

As described in TM-497, two stray muon beams were again found. However, by selectively turning off and on the cyclotron magnet in the Muon Lab and power supply 1W2 which controls the west bend in E-102, the sources of these two beams and their relative contribution to off-site radiation levels were determined. Figure 1 shows the contribution at the site boundary of the stray muon beams which originate in E101 and E104; it also shows the effect of the cyclotron magnet on the stray E104 beam.



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Table I. summarizes data taken under various conditions at the site boundary. Several items are worthy of notice:

- 1) Comparing Run #3 (E-398) with Run #5 (E-398), the dose rate at the site boundary increased 36% above what would be expected from an intensity increase alone. This increase is probably due to a tune change in the first dogleg. From Fig. 2, most of the 36% increase during Run #5 was from the stray E104 muon beam.
- 2) The dose rate at the site boundary decreased at the highest muon line momentum, 275 GeV/c (Run #2). This is due to the decreased production of muons at 275 GeV/c, as reflected in the low μ/p ratio.
- 3) Under the running conditions of E-398, (Run #5 from Table 1) 66% of the site boundary dose is from the E101 stray muon beam and 34% from the E104 stray muon beam. Therefore, if the muon line were to run again under similar conditions it would be necessary to bend both the E101 and the E104 stray muon beams into the ground. Otherwise the contribution from each stray beam would exceed 10 mrem at the site boundary within \approx one month for the E101 beam and 2-1/2 months for the E104 beam with 10^{13} ppp on target, continuously.

The data taken with LW2 off are a good set of measurements to compare to the predictions of the Monte Carlo program HALO (TM-680) since at present HALO is set up to only model the first dogleg of the muon line. The measurements taken at the

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boundary and at Lab A, with the MERL, and the HALO predictions are shown in Fig. 3. Measurements were also taken at E103 and the Muon Lab with a different instrument (a hand-held scintillation counter).^{*} These data from the Muon Lab measurements agree with the MERL measurements made at the Muon Lab. The renormalized data along with the HALO predictions are shown in Fig. 4. We can observe from the vertical measurements (made with the hand-held instrument) that the predicted and observed vertical distributions are much narrower than those in the horizontal (magnetic bend plane) direction. The overall comparisons at Lab A and the site boundary show that HALO is able to give an indication of the location and magnitude of the stray beams.

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TABLE I

RUN	MAIN RING ENERGY	MUON LINE MOMENTUM	μ/p	MREM/ PROTONS ON TARGET	MREM/YR* 10^{13} ppp		
					E101 BEAM	E104 BEAM	TOTAL
1 (Exp 99)	300	150	1.5×10^{-7}	0.69×10^{-18}	-	-	4.1
2 (Exp 319)	400	275	0.5×10^{-7}	1.8×10^{-18}	-	-	11.0
3 (Exp 398)	400	225	1.0×10^{-7}	4.25×10^{-18}	20.8	5.2	26.0
4 (Exp 398)	400	225	0.85×10^{-7}	4.9×10^{-18}	-	-	30.0
5 (Exp 398)	400	225	0.7×10^{-7}	5.8×10^{-18}	24.0	12.4	36.4

*mrem/yr - assuming 13 second repetition rate, 6 month/yr operation,
50% duty factor, and average intensity of 10^{13} proton/pulse.

Fig. 1 Muon Contributions at Site Boundary

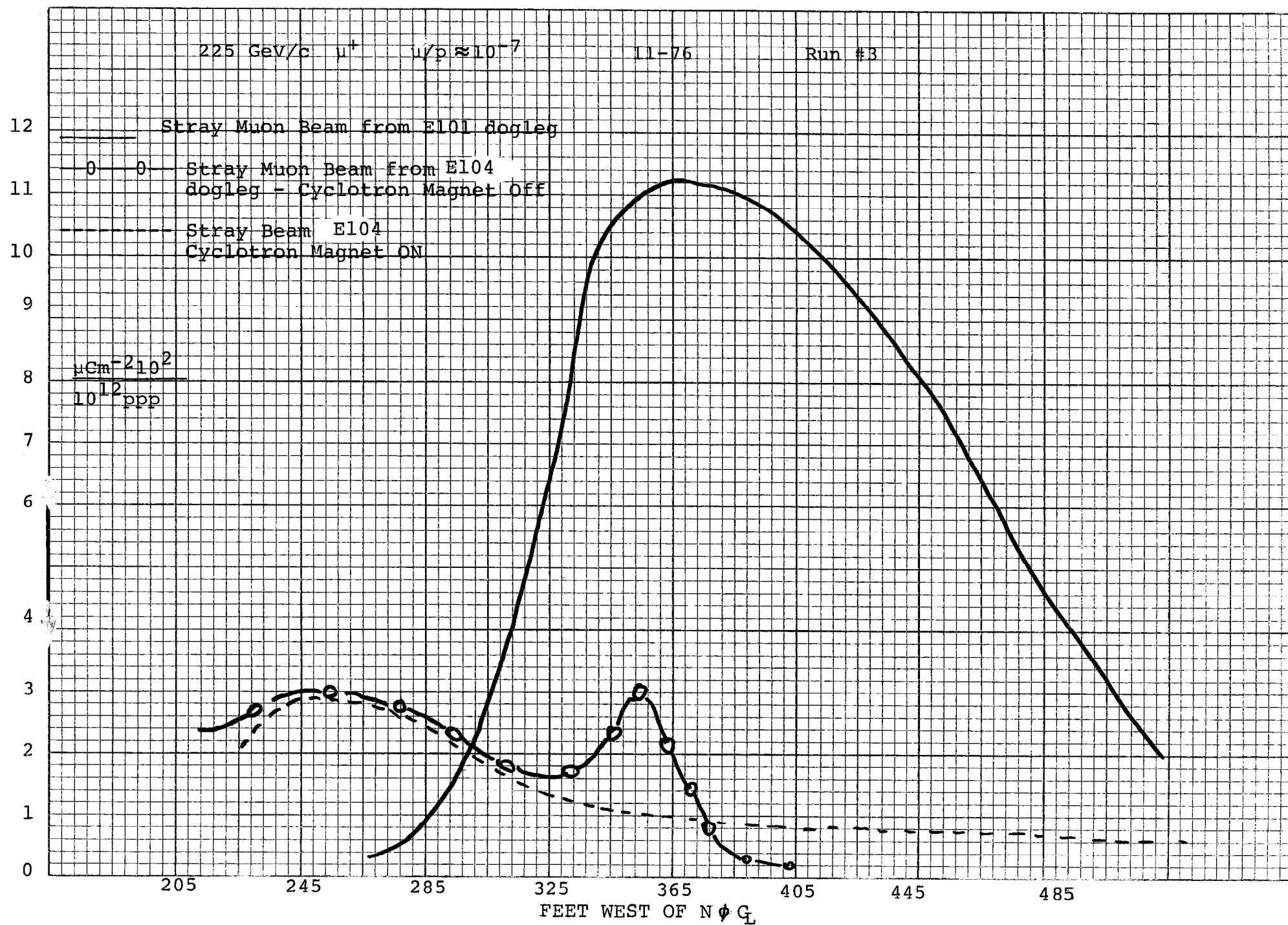


Fig. 2 Muon Contribution At Site Boundary Run #5/Run #3



Fig. 3 225 GeV/c μ^+ 1W2 Off (E101 Stray Beam)

